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Title: Changing trends in the management of intertrochanteric hip fractures - a single centre experience

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Abstract: With an annual incidence greater than 65,000 in the United Kingdom, hip fractures are a common but debilitating injury predominantly affecting those over 65. Treatment is based on the anatomical location of the fracture relative to the capsule of the hip joint - fractures occurring within it are treated by arthroplasty, while extracapsular fractures are an indication for fixation. Intertrochanteric fractures are further grouped as stable (AO/OTA 31A1/A2) or unstable (31A3) which in turn governs in the current UK guidelines whether this fixation is achieved with a dynamic hip screw or intramedullary device. Anecdotally, some units are tending towards intramedullary devices for 31A2 fractures as well, a practice which from the evidence does not appear to confer benefit and carries an excess cost. We reviewed our data submitted to the National Hip Fracture Database over the last five years and identified all intertrochanteric fractures, from which cohort we identified all patients with 31A2 fractures by review of radiographs. The cohort comprised 370 patients. We then recorded age, gender, ASA grade, abbreviated mental test score, residence from where admitted, length of stay, destination on discharge and whether any further operations were required. There was no significant difference in the demographics of the groups, year-on-year, except gender mix. There was a significant, twenty-fold rise in the use of intramedullary devices between 2011 and 2015. Length of stay, length of overall episode of care, revision rates, mortality and destination on discharge were unchanged. This use is not supported by NICE guidelines and this study offers no evidence to contradict this position. We advocate all centres examine their practice to avoid a costly intervention without clinical benefit.

Suggested Reviewers:

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Professor P. V. Giannoudis
Editor
Injury

15 February 2016

Sir,

I write to submit an original research article entitled "Changing trends in the management of intertrochanteric hip fractures - a single centre experience."

This article discusses the trends in the use of sliding hip screw and intramedullary nails for the management of AO/OTA 31A2 hip fractures. All authors have contributed to study design and conduct, manuscript drafting and production of the final submission. This work has not been published elsewhere and is not under consideration for publication elsewhere.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'P. V. Giannoudis', with a stylized flourish underneath.

***Conflict of Interest Statement**

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None of the authors have any conflicts of interest to declare

Changing trends in the management of intertrochanteric hip fractures - a single centre experience

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Abstract

With an annual incidence greater than 65,000 in the United Kingdom, hip fractures are a common but debilitating injury predominantly affecting those over 65. Treatment is based on the anatomical location of the fracture relative to the capsule of the hip joint - fractures occurring within it are treated by arthroplasty, while extracapsular fractures are an indication for fixation. Intertrochanteric fractures are further grouped as stable (AO/OTA 31A1/A2) or unstable (31A3) which in turn governs in the current UK guidelines whether this fixation is achieved with a dynamic hip screw or intramedullary device. Anecdotally, some units are tending towards intramedullary devices for 31A2 fractures as well, a practice which from the evidence does not appear to confer benefit and carries an excess cost. We reviewed our data submitted to the National Hip Fracture Database over the last five years and identified all intertrochanteric fractures, from which cohort we identified all patients with 31A2 fractures by review of radiographs. The cohort comprised 370 patients. We then recorded age, gender, ASA grade, abbreviated mental test score, residence from where admitted, length of stay, destination on discharge and whether any further operations were required. There was no significant difference in the demographics of the groups, year-on-year, except gender mix. There was a significant, twenty-fold rise in the use of intramedullary devices between 2011 and 2015. Length of stay, length of overall episode of care, revision rates, mortality and destination on discharge were unchanged. This use is not supported by NICE guidelines and this study offers no evidence to contradict this position. We advocate all centres examine their practice to avoid a costly intervention without clinical benefit.

Introduction

Hip fractures had an annual incidence in excess of 65,000 in 2015 (Royal College of Physicians 2015), cost over £1bn in hospital care alone (Leal et al. 2015) and represent a significant life-altering event for the patient. It has recently been demonstrated that these patients lose a significant quality of life permanently and, early in their recovery, a proportion rate their state of health as worse than being dead (Griffin, Parsons, Achten, Fernandez & Costa 2015b). While care has advanced substantially in recent years, there remains a significant burden of mortality associated with the injury (Holt et al. 2008).

Recognising the severity of the problem, the National Institute for Health and Care Excellence published Clinical Guideline 124 (CG124) in 2011, setting out a number of quality indicators for the care of these patients. These focused on pre-operative medical optimization, timely, consultant-led surgery and peri-operative care to avoid the common complications and co-morbidities.

The approach to the management of extracapsular (AO/OTA classification 31Ax) hip fractures is based on fixation, preserving the native femoral head by use of dynamic hip screw (DHS) or intramedullary devices to stabilize the fracture and allow the neck to collapse into a position of compression. While there exists some debate between surgeons over which defers confers biomechanically superior fixation, CG124 advocates DHS fixation for undisplaced, simple fractures (31A1) and 31A2 (multi-fragmentary fractures as distal as the lesser trochanter). Intramedullary fixation is limited to 31A3 (fractures with sub-trochanteric extension or inherently unstable, reverse-oblique fractures)[4–6].

The choice of implant is important as inadequate fixation will lead to cut-out of the device from the femoral head (Baumgaertner 1997), mandating revision surgery. Such surgery places the patient at greater risk and vastly increases the costs of the hip fracture to the NHS (Broderick et al. 2013).

The current evidence base suggests most 31A2 proximal femoral fractures can be managed with a DHS {Reindl:2015bw}. A recent cost-modelling analysis demonstrated increased cost-effectiveness of the DHS with a failure rate of up to 5%, after which nailing became the economically preferable option (Swart et al. 2014). Anecdotally, there has nonetheless been a shift in some units from DHS to intramedullary fixation for 31A2 fractures.

The aim of this study was to quantify the annual comparative volume of DHS and intramedullary fixation procedures and identify any differences in outcome.

Patients and methods

Our centre's submission dataset for the National Hip Fracture Database was queried to identify all those patients who had sustained intertrochanteric fractures between January 2011 and June 2015. The radiographs were all reviewed by one of three authors to exclude patients with 31A1 or A3 fractures. Other exclusion criteria were age below 65 years and pathological fracture (Figure 1). Ethical approval was not required for this evaluation of our service.

The data collected on each patient was: age; gender; American Society of Anesthesiologists (ASA) grade; Abbreviated Mental Test Score (AMTS); place of residence; surgery performed; dates of admission, surgery and discharge from acute ward, NHS trust and NHS care; discharge destination and date and nature of any further operations pertaining to this episode of care.

The patients were grouped by operation – DHS or intramedullary fixation (IMN). Places of residence on admission were coded as 1 (nursing, acute or rehabilitation care), 2 (residential care) or 3 (own home or sheltered housing) and discharge destinations were coded as 0 (did not survive to discharge), 1 2 or 3 as above. These codes were used as surrogates for levels of independence of function, the key objective of hip fracture surgery being the restoration of such function.

Our primary outcome measure was the number of DHS and IMN procedures performed each year. The secondary outcome measures were length of ward stay, length of the total episode of care, change in level of independence and requirement for further surgery.

Data were tested for normality by the Shapiro Wilk method. All comparisons were made by Chi squared testing for categorical and Mann Whitney U or Kruskal Wallis testing for continuous or ordinal data. Statistical analysis was performed using SPSS version 21 (IBM, New York, USA).

The available dataset for the relevant time period comprised in total 1086 patients. The number of patients meeting the inclusion criteria was 370 (Figure 1).

Results

Demographic information on the groups is given in Tables 1 and 2. The mean age was 85.99 (95% CI 85.27-86.71) years and 255 (68.9%) patients were female. The gender distribution of patients was significantly different by year and by implant group ($p<.001$). No significant differences existed in terms of age, co-morbidity, cognitive function or pre-injury level of independence of living when grouping patients by either year of surgery or implant used.

There was a significant ($p<.001$), year-on-year increase in the use of intramedullary nails (Figure 3).

There was no significant difference in the length of ward stay or duration of the care episode, although there were a large number of missing data points for the duration of care (Table 3). Both mortality and the distribution of level of independence of living on discharge was also similar between groups ($p=.192$)

Discussion

This is the first study to quantify temporal changes in the use of differing implants for AO/OTA 31A2 hip fractures in the UK and one of few to include a relatively large cohort with the newest generation of intramedullary devices. We have demonstrated a statistically significant year-on-year increase in utilisation of intramedullary devices without any change in length of stay, level of independence on discharge or requirement for further surgery. The trend in utilisation of nails from 3.8% of A2 fractures in 2011 to in excess of 57.6% at time of analysis in 2015 is not one driven by any change in patient characteristics within this time period. While this study was not able to ascertain the reason for implant selection, in a demographically unchanging cohort there is little suggestion that the proportion of unexpectedly unstable fractures should differ from year to year.

The excess implant cost to our centre when opting for intramedullary fixation is £884.01 (£1164.43 for the Synthes PFNA with compression screw and two distal locking screws *versus* £280.42 for the DHS with a four-hole plate and four cortical screws). Should trends in both usage and cost differentials be generalizable to any extent in a national context, the excess costs to the NHS could be in the order of millions of pounds.

The increased cost of IMNs has often been justified by claims of lower rates of complication, shorter length of stay or higher level of functional independence on discharge and hence reduced societal care costs for these patients. In this study, we have not demonstrated this to be the case and there has been a consistent absence from the literature of unequivocal evidence of superiority of intramedullary fixation. Aros et al's 2008 Medicare-based study of more than 43,000 intertrochanteric fractures demonstrated increased revision rates in the intramedullary fixation group and, when appropriately adjusting the data, increased length of stay, rehabilitation requirements and overall costs (Aros et al. 2008). Mortality was similar in both groups.

Giraud et al demonstrated equivocal outcomes of DHS and Targon intramedullary devices with less blood loss and shorter operative times in their 60 patient randomized trial (Giraud et al. 2005). Klinger et al found shorter operative time, length of stay and time to remobilization with the PFN over the DHS but this was in a cohort including patients with 31A2 and 31A3 fractures (Klinger et al. 2005). Liu et al's 2009 meta-analysis found no benefit in the Gamma nail over the DHS in seven studies, although there was a degree of heterogeneity in the studies included (Liu et al. 2009). While the PFNA and Gamma nail differ in design, the core concepts that some cite as conferring benefit, such as the shorter lever arm, are common across all such devices. Such theoretical benefits have not been proven in the literature to translate to a clinical advantage in A2 fractures. Any such potential benefit must also be balanced with nail-specific problems such as cortical perforation when the radius of curvature of bone and implant are mismatched.

Within the last year, a large randomized controlled trial of DHS *versus* IMN demonstrated that while IMNs conferred less femoral neck shortening, this did not translate to improved lower extremity measurement, functional independence

measurement or timed up-and-go scores (Reindl et al. 2015). No differences were seen in morbidity or mortality.

This study could be criticised for being observational . The similarity between cohorts in terms of age, gender, ASA grade and level of independent living pre-injury suggests, however, that the cohorts are broadly comparable. The gender of a number of patients was not readily accessible for the dataset and the largest variation in distribution of gender between subgroups in the cohort actually pertains to missing data; were all these available the significant differences may no longer exist. The single-surgeon classification of the fracture is also more prone to error than blinded double- or triple-classification. The proportion of fractures classified as 31A2 in 2013 is also not readily explicable from the data, but while the absolute number appears an outlier, the relative mix of operations that year was on-trend.

The single-centre nature of this study risks it being unrepresentative of wider practice but there has been anecdotal suggestion that trauma centres using more intramedullary fixation in routine practice for other fractures tend towards this when managing hip fractures; a multi-centre study would confirm or refute this theory. The number of surgeons operating in our centre over the five year study period also renders surgeon-dependent error unlikely and hence the implant-associated trends seen here are likely to be generalizable.

Discharge destination as an outcome measure may lack the depth of information of a scoring system but convincing arguments have been made that an adequate system specifically designed for hip fractures does not yet exist. While overall health indicators such as the EQ-5D have been accepted as reasonable compromises in that they can capture an adequate amount of information on these sometimes parlous health states and have adequate validity when completed by relatives or carers (Parsons et al. 2014), the ultimate question in hip fracture care is whether we are restoring pre-injury function to these patients. This has been qualitatively demonstrated to be patients' greatest concern when considering hip fracture (Griffiths et al. 2015) and clear effects have been shown in recent output from the Warwick Hip Trauma Evaluation (WHiTE) study (Griffin, Parsons, Achten, Fernandez & Costa 2015a; Griffin et al. 2012).

As this data is sourced locally rather than from national datasets, there is a possibility that patients who have experienced complications from their surgery have presented elsewhere and this episode has not been captured. There is no reason to believe this to be either a significant trend or one seen disproportionately in one group and the complication rate seen in the DHS group is also very similar to other UK-based analyses (Chirodian et al. 2005).

The findings of this study demonstrate a year on year increase in the use of intramedullary fixation for AO/OTA 31A2 hip fractures; these do not confer any benefits in terms of outcome and lead to higher treatment costs.

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Variable		Year group					<i>p</i>
		2011	2012	2013	2014	2015	
Number of patients n		52	85	131	69	33	
Gender n (%)	Male	18 (34.6)	20 (23.5)	34 (26.0)	12 (17.4)	9 (27.3)	<.001
	Female	34 (65.4)	63 (74.1)	96 (73.3)	53 (76.8)	9 (27.3)	
Mean age Yrs (95% CI)		85.22 (82.79- 87.64)	85.94 (84.48- 87.39)	86.26 (85.12- 87.40)	86.84 (85.35- 88.33)	83.91 (81.30- 86.53)	.311
ASA grade n (%)	1	0 (0)	1 (1.2)	3 (2.3)	2 (2.9)	1 (3.0)	.952
	2	11 (22.4)	20 (24.1)	39 (29.8)	19 (27.5)	11 (33.9)	
	3	31 (63.3)	52 (62.7)	73 (55.7)	39 (56.5)	19 (57.6)	
	4	7 (14.3)	10 (12.0)	16 (12.2)	9 (13.0)	2 (6.1)	
Mean AMTS (95% CI)		6.67 (5.57- 7.78)	6.87 (6.08- 7.66)	6.68 (6.08- 7.27)	7.14 (6.29- 8.00)	7.48 (6.32- 8.65)	.746
Admitted from n (%)	Own home or sheltered accommodation	36 (70.6)	60 (71.4)	104 (80)	57 (82.6)	29 (87.9)	.183
	Residential care	8 (15.7)	12 (14.3)	17 (13.1)	10 (14.5)	3 (9.1)	
	Nursing, rehabilitation or hospital care	7 (13.7)	12 (14.3)	9 (6.9)	2 (2.9)	1 (3.0)	

Table 1 – Patient demographics grouped by year

Table 2 – Patient demographics by implant

Variable		Implant		<i>P</i>
		DHS	IMN	
Number of patients n		267	103	
Gender n (%)	Male	74 (27.7)	19 (18.4)	<.001
	Female	187 (70.0)	68 (66.0)	
Mean age yrs (95% CI)		85.90 (85.05- 86.76)	86.03 (84.72- 87.33)	.881
ASA grade n (%)	1	4 (1.5)	3 (2.9)	.836
	2	73 (27.9)	27 (26.2)	
	3	154 (58.8)	60 (58.3)	
	4	31 (11.8)	13 (12.6)	
Mean AMTS (95% CI)		6.98 (6.55- 7.41)	6.63 (5.92- 7.33)	.392
Admitted from n (%)	Own home or sheltered accommodation	208 (78.8)	78 (75.7)	.348
	Residential care	32 (12.1)	18 (17.5)	
	Nursing, rehabilitation or hospital care	24 (9.1)	7 (6.8)	

Variable		Implant		p
		DHS	IMN	
Additional procedures required n (%)	Washout	3 (1.12)	2 (1.94)	.231
	Revision of / to IMN	1 (0.37)	2 (1.94)	
	Arthroplasty	3 (1.12)	0 (0.0)	
Mean length of ward stay days (95% CI)		5.92 (4.91-6.93)	6.31 (4.95-7.68)	.677
Mean length of episode of care days (95% CI)		18.71 (12.50-24.91)	31.03 (21.22-40.85)	.076
Discharged to n (%)	Own home or sheltered accommodation	37 (28.5)	4 (14.3)	.192
	Residential care	21 (16.2)	3 (10.7)	
	Nursing, rehabilitation or hospital care	61 (46.9)	16 (57.1)	
	Did not survive to discharge	11 (8.5)	5 (17.9)	

Table 3 – Outcomes by implant

Figure1

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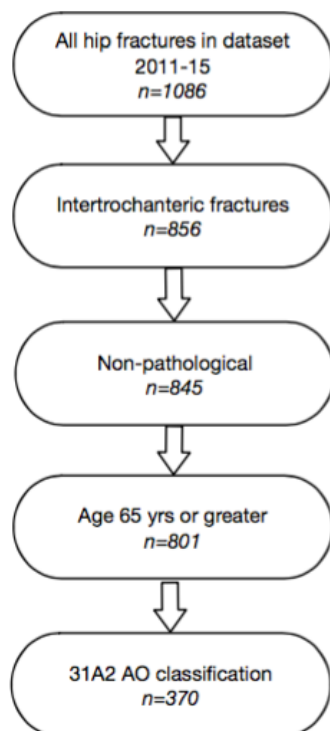


Figure2
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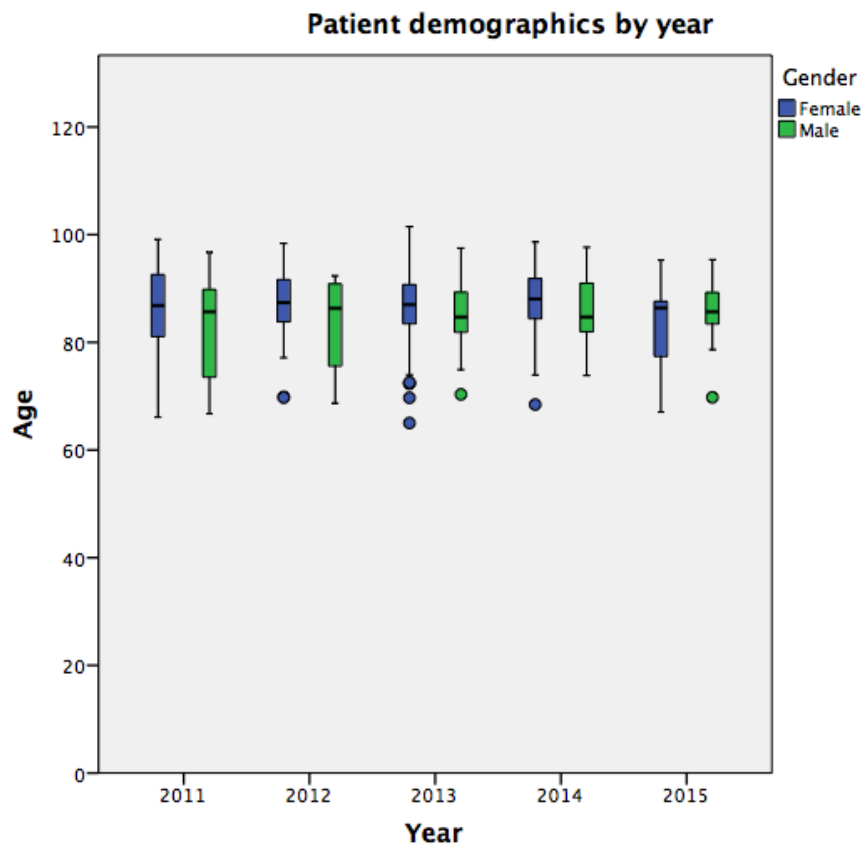


Figure3
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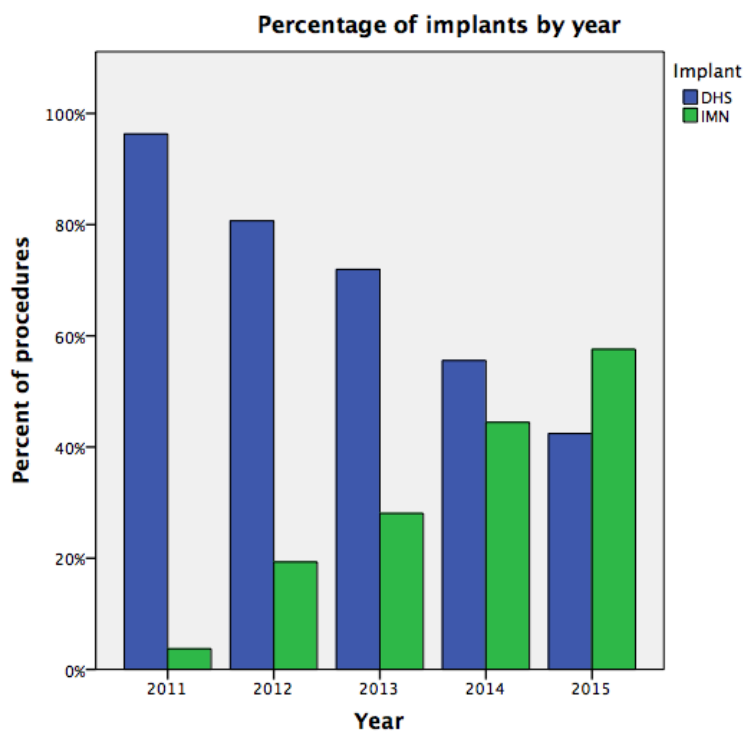
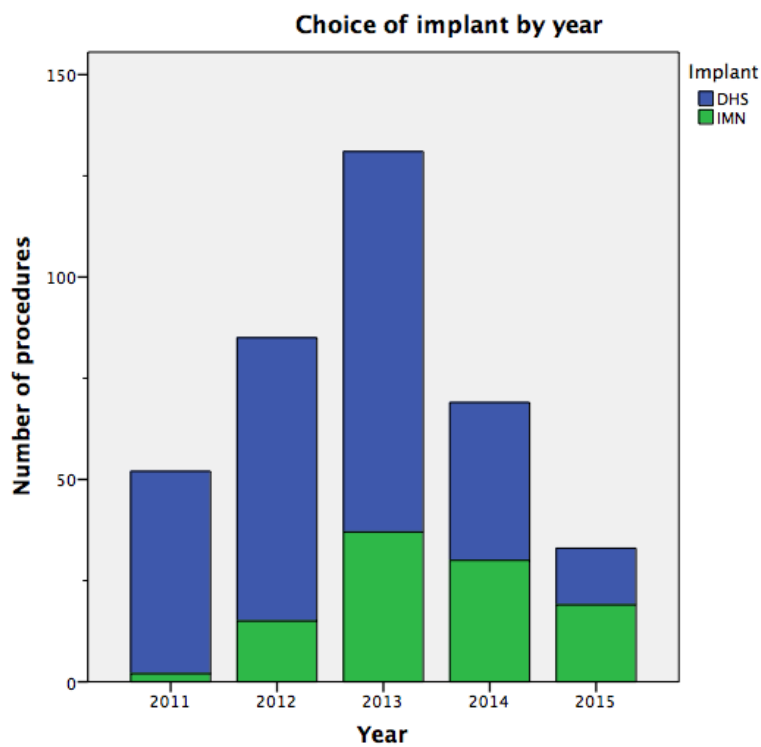


Figure Legends

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Fig 1 – Cohort flowchart

Figure 2 – Patient demographics by year

Figure 3a – Implant choice by year

Figure 3b – Percentage proportions of implant by year